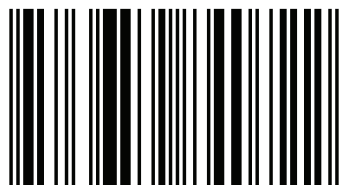


Modelling of Sand Entrainment and Deposits in Horizontal Oil Transport

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Engr. Sanni Samuel is a Lecturer in the Department of Chemical Engineering, Covenant University Ota, Ogun State, Nigeria. He attended Command Nursery, Primary and Secondary Schools in Nigeria between 1981 through 1996. He is a research fellow with great passion for research including Petroleum Processing, Reaction Engineering and Process Modelling.



978-3-659-84072-2

Modelling of Sand and Crude oil Flow

Olawale, Adefila (Eds.), Sanni

**Scholars'
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Samuel Sanni
Adegboyega Olawale (Ed.)
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Impressum / Imprint

Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über <http://dnb.d-nb.de> abrufbar.

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Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

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Coverbild / Cover image: www.ingimage.com

Verlag / Publisher:

Scholar's Press

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OmniScriptum GmbH & Co. KG

Bahnhofstraße 28, 66111 Saarbrücken, Deutschland / Germany

Email: info@omniscryptum.com

Herstellung: siehe letzte Seite /

Printed at: see last page

ISBN: 978-3-659-84072-2

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ABOUT THIS BOOK

This book is a product of the modeling and simulation studies of upstream sand crude oil transport. It seeks to bring to the mind of the reader, the current practices and the need for viable alternatives in order to curb losses accruing from conventional practices and work over operations. Its knowledge base includes the application of Mathematics, Physics, Computer Science and Chemical Engineering to resolve sand transport or deposition problems. This book is a compilation of the author's M.Sc Thesis in the Department of Chemical Engineering, Ahmadu Bello University Nigeria, 2009.

ACKNOWLEDGMENT

God is always first amongst all to whom I owe any deep sense of appreciation and is always worthy of my thanks. I also want to sincerely appreciate the passionate mentoring and leadership of Professor S.S. Adefila who also provided guidance as a father and mentor towards the successful completion of this work that has eventually become a book. I thank Dr. A.S. Olawale for his contributions, Professor M.T. Ityokumbol for providing some of the relevant literature, Professor I.M. Bugaje for his teachings of the subject, Transport Phenomena which forms the basic part of the modelling exercise, Dr. O. Ajayi for his assistance in providing links through which some relevant materials needed for the work were sought and obtained, Dr. B.O. Aderemi and Dr. I.A. Mohammed for their advice throughout the period of my studies at the Ahmadu Bello University, Zaria, Nigeria. I will not forget the assistance rendered by Dr. B.K. Jha, Department of Mathematics, an expert in Computational Mathematics who advised on the way to go about the mathematical simulations. To my parents, Mr and Mrs Matthew Sanni, I remain indebted to you for your invaluable investment all through my academic pursuit and support all through the stages of development of the different chapters of this book. I also thank the staff of Afrac, an oil service organization in PortHarcourt, Nigeria, that helped in providing the necessary information and details on events upstream, including sand monitoring and sand detection operations during crude oil transport.

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NOMENCLATURE

Symbol	Designation	Unit
A	Cross-sectional area	m^2
g	Gravitational acceleration	ms^{-2}
P_f	Fluid phase pressure	$\text{kgm}^{-1}\text{s}^{-2}$
P_k	Kinematic pressure	$\text{kgm}^{-1}\text{s}^{-2}$
P_s	Solid phase pressure	$\text{kgm}^{-1}\text{s}^{-2}$
q_f	Volume flow rate of oil	m^3s^{-1}
q_s	Volume flow rate of sand	m^3s^{-1}
t	Time	hrs or s
V_m	Volume of mixture	m^3
V	Volume	m^3
w_f	Oil velocity	ms^{-1}
w_s	Sand velocity	ms^{-1}
z	Axial distance	m
β	Fluid-particle interaction coefficient	$\text{kgm}^3\text{s}^{-1}$
Δz	Change in length	m
ε	Oil concentration (volume fraction)	-
ϕ	Suspended sand concentration (volume fraction)	-

ρ_f	Oil density	kg/m^3
ρ_s	Sand density	kg/m^3
σ	Sand deposit concentration	-

PREFACE

Some oil and gas reservoirs in Nigeria are often weakly consolidated, making them liable to sand production. During upstream petroleum production operations, light oil and sand mix from the reservoirs are produced through wells dug into formation zones and transported through horizontal pipes between well heads and flow stations. The residual sand transported through the pipes pose serious problems such as, blockage and, reduction of pipe efficiency and integrity. A mathematical simulation of the transport process of crude oil and sand in a horizontal pipe is discussed in this book. The model used is a modified form of the Doan *et al* (1996 and 2000) models. The effect of eddies in three regions was incorporated in the mass and momentum equations of the model and a third equation for solid phase was also developed. Difference formulae were generated for the conservation equations by applying Fick's equation for diffusion as a basis for the origin of the finite difference formula. The diffusion equation was modified and applied to the momentum phase equations so as to make the model have a clear solution. The method adopted in this book, rather than the usual method of solving models of this type simultaneously, solves the model equations directly. The sand deposit points, oil distribution, velocities of oil and sand, forces (gravity, inertia, interaction, solid and fluid phase pressure forces) and most importantly, oil volume flow were simulated on hourly basis. Chapters one through to four explains how transport principles were adopted in controlling sand deposition problems.